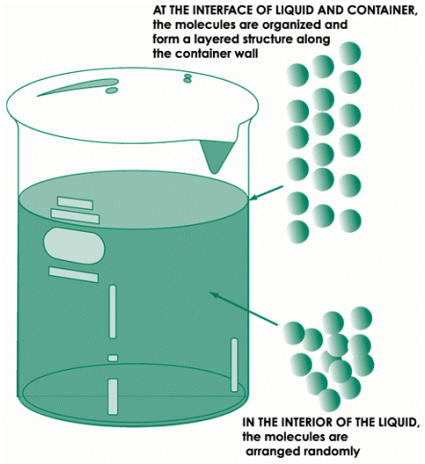
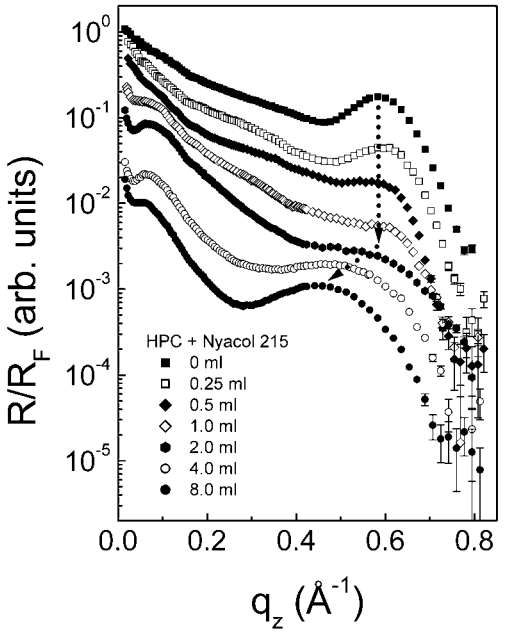
Molecular reorganization in cellulose-derivative thin films in the presence of silica nanoparticles

Pulak Dutta, Northwestern University, DMR-0305494



How molecules are arranged in materials determines the properties of the material—if the arrangement can be changed, materials with new properties can be made. We are finding ways to modify the molecular arrangements within molecular (cellulose-derivative) materials by using interfaces to align them, as shown in the schematic diagram (top left), and then embedding inorganic particles in them to form a composite organic-inorganic material.

Polymer **45**, 6269 (2004) ; *Langmuir* **20**, 1698 (2004)



Synchrotron X-ray reflectivity data showing how the structure of hydroxypropyl-cellulose thin films changes when increasing amounts of colloidal silica are added.

Disordered materials can partially order when near an interface---the interface “fools” the molecules into arranging in ways that would not be seen in a bulk material. With support from NSF, we have been studying the ordering of molecular (organic) materials very near a hard substrate. We have recently found that introducing inorganic nanoparticles into the organic ultrathin film can significantly change the arrangements of the molecules. We studied these composite materials using the scattering of x-rays produced by synchrotron sources; x-rays are a very sensitive probe of order at the nanoscale. (In the long run, we hope that by understanding why and how the molecular arrangements change, we can produce materials with tailor-made structures and thus tailor-made properties.) This work was published in the journals *Polymer* (2004) and *Langmuir* (2004).

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Education:
This work is performed in a Physics department but is at the interface of physics, chemistry and materials science. Students and postdocs receive training in a wide variety of areas and graduate with broad interests and abilities.

Two postdocs (Evmenenko, Yu) and one graduate student (Kewalramani) contributed to this work . Yu now holds a staff position in a synchrotron facility; the others are still in working in our group.

Societal Impact:
Every day, our daily lives benefit from and even depend on applications of materials that were unknown a few years or decades ago. By developing, and trying to understand, methods to arrange molecules in new ways, we are working towards the materials of the future.